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Article

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OPERATIONS, INFORMATION & TECHNOLOGY | RESEARCH ARTICLE

Challenges of big data adoption in Malaysia SMEs based on Lessig's modalities: A systematic review

Min Hooi Chuah^{1*} and Ramayah Thurusamry¹

Abstract: This study aims to review the challenges of implementing big data analytics by Small and Medium Enterprises (SMES) in Malaysia. There is a lack of literature studies examining the relationship between Lessig's four modalities and the challenges of big data analytics adoption. This study assesses the implementation of Lessig's Four Modalities for the adoption of big data analytics in Malaysia SMEs based on literature review findings. To identify the challenges of applying big data analytics in Malaysian SMEs, a comprehensive literature search was conducted using databases, journals, Google Scholar, and IEEE publications. This research provides practical insights into the challenges of dealing with big data in SMEs. It is envisioned that Lessig's four modalities proposed in this study, namely legal, architecture, social, and market factors, can be applied by Malaysian SMEs to adopt big data analytics.

Subjects: Social Impact of Computing & IT on Society; Privacy & Data Protection; Artificial Intelligence; Information & Communication Technology; ICT

Keywords: Big data analytics; challenges; Lessig's Four Modalities; legal; architecture; social; market; SMEs



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DR. CHUAH MIN HOOI received her PhD from Universiti Tunku Abdul Rahman in the area of Business Intelligence in 2019. She was a part time lecturer at several universities such as UCSI University, Kolej Tunku Abdul Rahman, First City University College. Currently, she is a postdoctoral fellow in Universiti Sains Malaysia. She started his teaching career as a lecturer with the joined Universiti Tunku Abdul Rahman (UTAR) in the Faculty of Information and Communication Technology in Perak Campus (FICT-PK). Professor Ramayah Thurusamry is currently attached to the Operations Management section at the School of Management, Universiti Sains Malaysia. He has also presented numerous papers at local and international conferences having won five Best Papers awards. He also serves on the editorial boards and program committee of several international journals and conferences of repute. He has completed 23 funded research projects. He has published 285 research articles in journals contributed as author/co-author. He is also acting as reviewer for several journals.

PUBLIC INTEREST STATEMENT

This study aims to review the challenges of implementing big data analytics by Small and Medium Enterprises (SMES) in Malaysia. There is a lack of literature studies examining the relationship between Lessig's four modalities and the challenges of big data analytics adoption. This study assesses the implementation of Lessig's Four Modalities for the adoption of big data analytics in Malaysia SMEs based on literature review findings. Specifically, a comprehensive literature search was performed from different databases, journals, Google scholar, and IEEE papers to identify the challenges of implementing big data analytics in Malaysia SMEs. This study offers practical insights into the complexities of tackling big data in SMEs. It is envisioned that Lessig's four modalities proposed in this study, namely legal, architecture, social, and market factors, can be applied by Malaysian SMEs to adopt big data analytics.

1. Introduction

Big data consist of huge datasets, whereby the size of these datasets often exceeds the collection, management, use, and processing capabilities of human beings in an acceptable time. Furthermore, the scale of big data is always changing. A single dataset, for example, might be anything from terabytes (TB) to petabytes (PB) in size as of 2012 (PB).

In 2001, Doug Laney, an META Group (now Gartner) analyst, noted that the challenges and opportunities of data growth consist of three directions, namely volume (volume, data size), velocity (velocity, data input and output speed), and changeability (variety, diversity), collectively referred to as “3 V” or “3 Vs”. Gartner and most companies in the big data industry continue to use 3V to describe big data. In 2012, the definition of big data was revised by Gartner as follows: “Big data is a large, high-speed, and/or changeable information asset. It requires new processing methods to promote stronger decision-making capabilities, insights, and optimised processing. Additionally, some organisations have defined the fourth V characteristic known as Veracity.

To date, the global business ecological environment has undergone tremendous changes due to the rapid technological developments.

2. Big data analysis

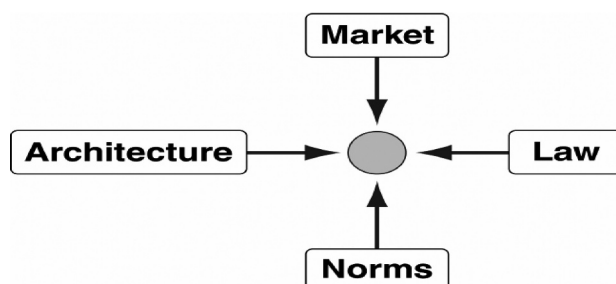
Mobile smart terminals, the Internet of Things, and cloud computing are all contributing to the big data phenomenon’s current trend. For example, in a manufacturing organisation, big data analysis can be used to monitor processes and spot faults. Managers can swiftly identify problems, abnormalities, and flaws using big data analysis, and then solve them to improve the company’s operations. As a result, industry can improve energy efficiency and productivity by utilizing big data analysis (Shang & You, 2019).

The big challenges of an industry to implement big data are IT infrastructure. The good IT infrastructure is needed for a company to process information, connotation data storage to more integrated and export-oriented system. Besides that, companies need to pay attention to the complete data life cycle, including data quality, data retention, data integration, data security, and information privacy and intellectual property rights (Hariri et al., 2019).

3. Challenges of big data analytics in SMEs

The challenges of big data analytics in SMEs are summarised below based on Lessig’s Four Modalities (Figure 1). Lawrence Lessig, a Harvard University professor, pointed out four different forces that affect blockchain governance: laws, social norms, markets, and architecture (i.e., the underlying technical infrastructure). He emphasised that it was not simply adequate to focus on designing rules specifically for management or the management of a certain person. In contrast, a broader ecosystem approach needed to be adopted to study the various forces that affect the blockchain. Therefore, when advocating or excluding certain behaviours, it is possible to directly supervise individuals through the legal system, or indirectly supervise them through the other three forces (market, social norms, and system structure).

Figure 1. Lessig’s four modalities
(source: Lessig, 2009).



According to Lessig's four modalities, internet usage is governed by four ways:

- Code/architecture—the physical or technical constraints on activities (e.g., locks on doors or firewalls on the Internet)
- Market—economic forces
- Law—explicit mandates that can be enforced by the government
- Norms/social—social conventions that one often feels compelled to follow

4. Methodology

The approach employed in this study involves a comprehensive library search and literature review on Malaysia SMEs and various challenges highlighted, irrespective of economical, organisational, or managerial aspects. The library search consists of online and offline content, ranging from newspaper articles to book articles.

4.1. Scope

The challenges faced by SMEs are not only limited to Malaysia but also challenges faced by Malaysia SMEs globally in the past 5 years.

4.2. Selection criteria

Journal articles were chosen from popular management databases and high-ranking journals, namely ISI Web of Science, Scopus, and Emerald (keyword: SME challenges). The inclusion criteria include big data analytics, SMEs, and challenges. The exclusive criteria include outside Malaysia and articles published before 2016.

Figure 2 shows the PRISMA flowchart developed for this study. In total, 147,000 articles were identified from the web of science and 128,000 articles were subsequently excluded and filtered out as these publications were published before 2016 and only concentrated on SMEs in Malaysia. As a result, only 21 articles were included in this study.

5. Results and analysis

A summary of the challenges of big data analytics faced by Malaysia SMEs are shown in Table 1.

Figure 2. PRISMA flowchart (developed by: authors).

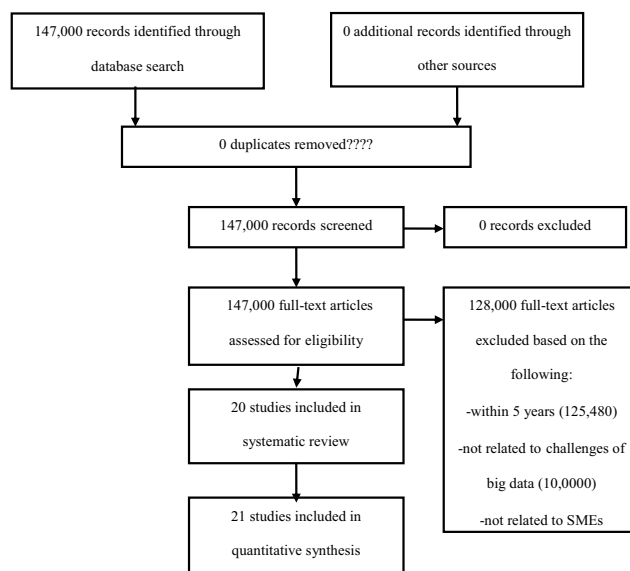


Table 1. Summary of challenges of big data analytics faced by Malaysia SMEs (developed by: authors)

Challenges	Author (Date)
Legal	Coleman et al. (2016), Iqbal et al. (2018), Del Vecchio et al. (2018), Ardagna et al. (2016), Vajjhala and Ramollari (2016), Kiziltan (2018), Kalan and Unalir (2016), Karim et al. (2017), Sivarajah et al. (2017), and Makhele (2018).
Architecture	Coleman et al. (2016), Shah et al. (2017), Del Vecchio et al. (2018), Soroka et al. (2017), Ardagna et al. (2016), Vajjhala and Ramollari (2016), Kiziltan (2018), Moyne and Iskandar (2017), Kalan and Unalir (2016), Karim et al. (2017), Mbassegue et al. (2016), Seseni and Mbohwa (2018), Sivarajah et al. (2017), Gupta et al. (2018), Limpeeticharoenchot et al. (2020), Makhele (2018), and Rajabion (2018).
Social	Coleman et al. (2016), Shah et al. (2017), Iqbal et al. (2018), Ardagna et al. (2016), Kiziltan (2018), Kalan and Unalir (2016), Karim et al. (2017), Mbassegue et al. (2016), Sivarajah et al. (2017), Baharuden et al. (2019), Limpeeticharoenchot et al. (2020), and Makhele (2018).
Market	Coleman et al. (2016), Shah et al. (2017), Iqbal et al. (2018), Soroka et al. (2017), Kiziltan (2018), Kalan and Unalir (2016), Limpeeticharoenchot et al. (2020), Makhele (2018), and Nemati and Khajeheian (2018).

Figure 3. Number of articles published from 2016 to 2020 (developed by: authors).

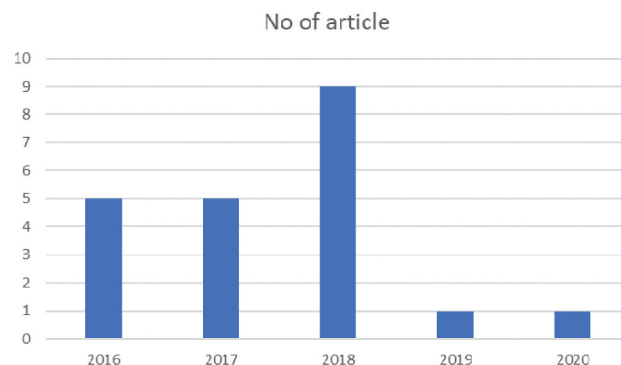


Figure 3 shows the number of articles selected for review in this study. In total, 5 articles were found in 2016 and 2017, respectively, 9 articles were found in 2018, and one article was found for 2019 and 2020, respectively.

Table 1, Figure 4, and Figure 5 summarise the challenges of big data analytics faced by Malaysia SMEs. The four main challenges identified in this study can be classified as legal, architecture, social, and market factors. Among the 21 journals reviewed, 17 articles (80.9%) listed architecture perspectives as one of the main challenges, while 10 articles (47.6%) noted legal issues as a factor. On the other hand, 12 articles (57.1%) and 9 articles (42.8%) listed social perspective and market perspective, respectively.

5.1. Legal perspectives: Concerns about data protection and data privacy

Data protection and data privacy pose a big challenge in big data analysis, particularly for SMEs (Jagadish et al., 2014). Jambunathan and Venkatesan (2016) noted that the possibility of misuse of personal data particulars was likely to occur in big data analysis. Due to data protection and security issues, the adoption of big data especially in funding agencies,

Figure 4. Overview of articles highlighting the four main challenges (developed by: authors).

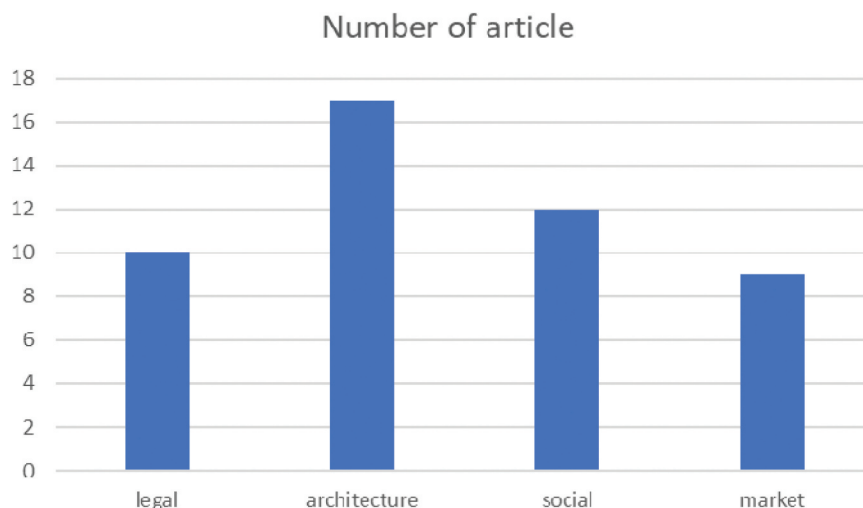
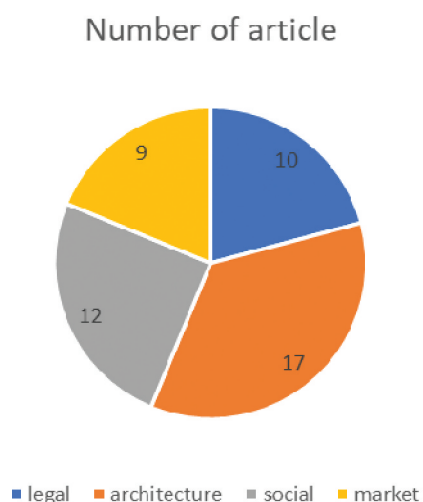


Figure 5. Pie chart-findings (developed by: authors).



academic, and medical sectors is much lower (Mardis, 2016). Several researchers have conducted studies on data privacy and security. For example, Sorensen et al. investigated privacy issues regarding the hosting of open accessible servers. Coleman et al. (2016) pointed out that it is also critical to find someone with knowledge of the law, thus requiring an additional budget to hire a lawyer. However, Malaysia SMEs are not in the position to bear these additional costs.

5.2. Social perspectives

Another issue regarding the adoption of big data analytics in Malaysia SMEs is organisation culture (Aishah et al., 2018). Coleman et al. (2016) stated that people in the organisation are not willing to share information and there is a need to establish a non-hierarchical culture of trust. Manyika et al. (2011) from McKinsey's study noted that people within the organisation need to be open-minded and willing to change their way of thinking. Smith (2007) suggested that the culture or social norms in the country also influenced the adoption of big data analysis particularly in SMEs.

5.3. Architecture perspectives: Lack of infrastructure to process high volume data efficiently

One of the big data challenges faced by SMEs is infrastructure. Organisations need proper server equipment, high processors or middleware to handle big data. Due to competitive advantages, the organisation needs to handle and interpret data quickly and efficiently (Laney, 2001). However, SMEs are facing a huge challenge as they cannot interpret data quickly enough due to the lack of infrastructure (Del Vecchio et al., 2018).

Jagadish et al. (2014) mentioned that the main challenge for SMEs is the ability to respond to complex queries with vast columns of data. Kalan and Unalir (2016) stressed that it is difficult for SMEs to overcome this problem due to their low budget and limited number of employees in their organisation. Marx (2013) also noted that the flow of information was slow due to the decentralisation of the data storage centres for the cloud systems. For example, users in the United States and Japan are losing customers as they face difficulties retrieving data quickly as the hardware is located in the United Kingdom (Jagadish et al., 2014).

5.4. Market perspectives: Highly complex analytics solutions in the software market

One of challenges faced by SMEs is the limited availability of existing analytical software tools in the market. For instance, it is very difficult to find analytical solutions with powerful analytical capabilities as well as interactive user-friendly features (Coleman et al., 2016; Aishah et al., 2018). There are two types of analytical software tools available in the market (Coleman et al., 2016; Iqbal et al., 2018). The first type of software consists of complicated solutions that are not suitable for SMEs due to the lack of expertise in data analytics (Coleman et al., 2016). The second type of software is simple but not useful (Coleman et al., 2016; Iqbal et al., 2018). For example, IBM's Watson Analytics software has a nice user interface with complex analytical functions and a shorter learning curve (Probst et al., 2014).

6. Practical implications

The findings of this study contribute to both the theoretical and practical perspectives of big data challenges in Malaysia SMEs that are beneficial to academicians and practitioners. From a theoretical standpoint, this study examines the relationship between the legal, architecture, social, and market factors that pose a challenge to Malaysia SMEs. Currently, there are limited studies examining the relationship between Lessig's Four Modalities and the challenges of big data analytics. Thus, through this study, academicians and practitioners will clearly understand how Lessig's Four Modalities can affect the adoption of big data analytics in Malaysia SMEs.

In terms of the practical perspectives, this study is beneficial to organisations and managers. For instance, from a managerial perspective, the organisation is able to identify the challenges in dealing with big data issues, thus giving them a competitive edge for improved decision-making capabilities in the future.

7. Conclusions and future work

This study evaluated the challenges faced by Malaysia SMEs based on Lessig's Four Modalities, namely the legal, architecture, social, and market issues. Based on the review of previous literature studies in this field, it is evident that there is a need to highlight a more comprehensive framework for identifying the challenges faced by Malaysia SMEs. The discussion of common challenges for both small and medium-sized enterprises requires considerable attention from both the government and non-governmental organisations to successfully address these challenges and convert them into opportunities to develop their full potential. Present literature studies have also described the difficulties that exist in Malaysia SMEs, irrespective of the social, architecture, legal, and market issues. The growing number of case studies in Malaysia reflect the need to improve the survival rate of SMEs, thus maximising their performance.

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